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Are individual-level factors necessary for creativity? A necessary condition analysis

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Abstract

Are individual-level factors necessary for creativity to occur in the workplace ? Using a novel statistical approach, Necessary Condition Analysis, we tested empirically the hypothesis that individual factors (conative factors, drivers, and creative process engagement) were critical to creativity in the workplace, using a sample of 1384 workers in France. We examined three known conative factors of creativity: openness to experience, creative personality, and creative personal identity. We examined three types of drivers: intrinsic motivation, job self-efficacy and creative self-efficacy. Additionally, we examined creative process engagement. We observed that all conative factors were necessary for creativity, even though they each showed small effect sizes. We found a similar small effect size for creative process engagement. We found that creative self-efficacy was a critical driver for creativity: an employee will not be able to achieve high creative performance if he or she does not have strong confidence about his or her creative capacities, regardless of other factors. However, neither job self-efficacy nor intrinsic motivation proved to be necessary for creativity: their absence can be compensated by other factors. Our findings highlight the need to distinguish between what makes a variable “important” or “necessary”, in the field of creativity and innovation.

Keywords: creativity, creativity in the workplace, individual factors, motivation, necessary condition analysis.

Are individual-level factors necessary for creativity? A necessary condition analysis

Are there necessary conditions for creativity and innovation? There is an large literature on individual-level factors that contribute to creativity at work (Da Costa et al., 2015; Hammond et al., 2011; Ng & Feldman, 2012), with special attention concerning openness to experience, creative process engagement, self-efficacy, and intrinsic motivation. However, although findings show clearly the importance of those determinants for creativity, they do not indicate whether some level of these variables is absolutely required or not. Correlation and regression analyses are mostly based on sufficiency logic (Dul, 2016): the presence of condition X is sufficient to increase outcome Y; but this is not the same as a necessary condition, as outcome Y can be increased by other factors in the absence of condition X. Necessity logic works differently: in the absence of condition X, there can be no outcome Y; when X is present, the presence of Y is enabled but not guaranteed. An important caveat is that necessity does not equate with causality, but indicates, rather, that certain conditions needs to be present for the outcome to occur. The definition of creativity can be used to exemplify this logic. Creativity refers to the capacity to generate original and appropriate ideas (Runco & Jaeger, 2012). To be considered creative, an idea needs to be original: without it, creativity is absent. Originality is necessary to enable creativity, but not sufficient: an original idea that is not appropriate cannot be considered creative.

Necessity logic is common in organizational sciences (Dul, 2019), and this is the case for the field of creativity and innovation (e.g. Aguilar-Alonso, 1996; Ang et al., 2014; Zhou & Shalley, 2007). The most relevant instance of necessity in the creativity literature can be found in componential theories of creativity (see Lubart, 1999). For example, Amabile (1988, 2012) posits the necessity of three individual-level components for creativity to emerge: domain-relevant skills, creativity-relevant processes, and task motivation. Domain-relevant skills correspond to expertise, intelligence, and knowledge in a particular domain. Creativity-

relevant processes refer to cognitive and personality factors conducive to creative thinking (Amabile & Pratt, 2016), such as openness to experience or creative personal identity. Task motivation is best exemplified by intrinsic motivation, the motivation to do the task for itself, because it is interesting or challenging (Amabile, 2012). In the componential approach, motivation is regarded as the driver, that “makes the difference between what an individual *can* do and what one *will* do” (Amabile, 1988, p. 133). Another variable that influences the motivation to engage in particular behaviors is self-efficacy, confidence in one’s abilities (Bandura et al., 1999). Consistent with prior research, we conceptualized it as a form of driver as well.

Drawing on the componential approach, we attempted to explore whether certain individual factors were empirically necessary for creativity to occur in the workplace. We focused on three conative factors related to creativity: creative personality, openness to experience and creative personal identity. We focused also on three particular drivers for creativity: intrinsic motivation, job self-efficacy and creative self-efficacy. As creativity in the workplace emerges from an individual creative process (Amabile & Pratt, 2016; Reiter-Palmon & Illies, 2004), we examined additionally creative process engagement. The conceptual model is shown in Figure 1. We used a novel statistical approach to testing necessary conditions, the Necessary Condition Analysis (NCA, Dul, 2016).

Theoretical background

Conative factors

Creative personality. Personality refers to preferred ways of behaving. According to some authors (see Feist, 1998, 2017), it is possible to identify individuals with a creative personality. People with a creative personality tend to have broad interests, show high tolerance for ambiguity, accept competing views, and are perseverant while developing their

ideas (Barron & Harrington, 1981). They should therefore be more creative, in their life and in their job. This argument has been largely corroborated over the last decades (e.g. Hammond et al., 2011; Oldham & Cummings, 1996; Zhou & Oldham, 2001). Notably, Oldham & Cummings (1996) found a positive relationship between employees' creative personality and multiple indicators of creative performance (i.e. patent disclosures written, contributions to an organization suggestion program, supervisory ratings). Hammond and colleagues' meta-analysis (2011) found an overall moderately strong relationship between creative personality and innovative performance ($\hat{\rho} = .25$). Based on these results, we hypothesize the following :

Hypothesis 1: Creative personality is necessary for creativity in the workplace.

Openness to experience. Openness to experience is one of the five core dimensions of personality, according to the Big Five model (Dollinger et al., 2004). This personality trait includes characteristics such as imaginativeness, curiosity and broadmindedness (Costa & McCrae, 1992). People with high openness are also more sensitive to aesthetics and more unconventional. Out of the Big Five factors, openness to experience is the trait that is most closely and consistently tied to creativity, conceptually and empirically. Conceptually, early works (e.g. Barron & Harrington, 1981) showed that descriptions of individuals high on openness were most often equivalent to those of creative ones, notably in terms of independent thinking and non-conformity. Numerous studies have since validated this conceptual proximity. Early on, McCrae (1987) found a strong link between openness to experience and two components of creative potential, namely divergent thinking and creative personality. A meta-analysis conducted by Feist (1998) demonstrated that openness was the most consistent trait of personality related to artistic and scientific creativity. In a recent meta-analysis (Hammond et al., 2011), a moderately strong correlation was found between openness and employee creativity ($\hat{\rho} = .24$), suggesting this relationship applies in the

workplace as well. More open individuals are more curious and imaginative, engage in more creative activities (Silvia et al., 2014), and seem to be more prone to participate in activities and projects that require creativity. As a result, we hypothesize the following:

Hypothesis 2: Openness to experience is necessary for creativity in the workplace.

Creative personal identity. Identity can take two forms: social or personal (Turner & Onorato, 1999). Social identity is derived from one's association to a group and comparison to other groups, whereas personal identity is self-focused and reflects the importance of a construct that one holds as critical to one's self-concept (Onorato & Turner, 2004). Creative personal identity is thus defined as the belief that creativity is an important element of one's self-description, i.e. how important being creative is to define one's identity (Jaussi et al., 2007). It is comprised of the overall importance of creativity and is therefore relatively stable and general (Jaussi et al., 2007). Creative personal identity should be related to creativity, because individuals tend to engage in behaviors based on their identity (Shamir, 1990). Jaussi et al. (2007) demonstrated this relationship by showing that senior managers' creativity was predicted by their creative personal identity. It is also a moderator of the relationship between creative potential and creative achievement (Karwowski & Lebuda, 2017), as having high creative personal identity increases the chance that one will commence creative endeavors. Based on these results, we hypothesize the following:

Hypothesis 3: Creative personal identity is necessary for creativity in the workplace.

Drivers

Intrinsic motivation. Intrinsic motivation refers to the drive to engage in an activity primarily for its own sake, because it is inherently interesting, engaging, satisfying or pleasurable (Amabile et al., 1994; Deci et al., 1989). It has been conceptualized as a key driving force for creative performance in numerous theories (Amabile & Pratt, 2016; Ford,

1996; Sternberg, 2018). Having creative potential is not enough in order to initiate creative performance: as stated previously, motivation is what makes the difference between what an individual *can* do and what they *will* do. An extensive and ever-growing body of literature has demonstrated intrinsic motivation was conducive to creative performance. Hammond and colleagues' meta-analysis (2011) showed a moderately strong relationship between intrinsic motivation and employee creativity ($\hat{\rho} = .24$). A review of meta-analyses on personal factors of creativity (Da Costa et al., 2015) reached the same conclusion ($\hat{\rho} = .20$). Creative effort requires high levels of concentration, grit and energy, hence intrinsic motivation should be critical to drive this very effort.

Hypothesis 4: Intrinsic motivation is necessary for creativity in the workplace.

Job self-efficacy. Self-efficacy refers to one's beliefs about their capabilities to organize and execute courses of action required to produce desired results (Bandura et al., 1999). Even if there exist generalized conceptions of self-efficacy (see Jerusalem & Schwarzer, 1995), it has primarily been conceptualized in terms of task-specific beliefs (Bandura & Walters, 1977; Riggs et al., 1994). In our context, job self-efficacy refers to beliefs about one's competence regarding his or her job performance. Because performance capability is a precursor to creative capability in a given domain (Amabile, 1988), some scholars have posited that job self-efficacy is a precursor and a moderator of creativity at work (i.e. Tierney & Farmer, 2002). Farr & Ford (1990) proposed that job self-efficacy should influence individual role innovation (i.e. the introduction of new behaviors into a pre-existing role) as having high confidence should allow for more initiative-taking and more proactive behaviors. Consistent with these arguments, Axtell et al. (2000) showed that employees with higher job self-efficacy were more autonomous and made more suggestions. Tierney & Farmer (2002) demonstrated job self-efficacy correlated with employee creativity, notably in the manufacturing industry. Hammond and colleagues' meta-analysis (2011) found

an overall moderately strong relationship between job self-efficacy and innovative performance ($\hat{\rho} = .26$). Without confidence in one's ability to perform their job well, one should not be able to perform it creatively.

Hypothesis 5: Job self-efficacy is necessary for creativity in the workplace.

Creative self-efficacy. Creative self-efficacy corresponds to the belief that one has the ability to be creative, i.e. that one is able to handle problems that require creativity (Karwowski et al., 2013; Tierney & Farmer, 2002). Over the two last decades, there has been a growing interest in this construct, in multiple fields (e.g. education, psychology, organizational sciences). Creative endeavors are, by nature, challenging and require grit, and a driver is necessary to “propel individuals toward creative action” (Farmer & Tierney, 2017, p. 36) and sustain perseverance through effort. The scientific literature has largely corroborated this argument: creative self-efficacy is a strong predictor of creativity at work. Hammond and colleagues' meta-analysis (2011) demonstrated a moderately strong relationship between creative self-efficacy and employee creativity ($\hat{\rho} = .33$). It is worth noting that creative self-efficacy proved to be the strongest predictor of creativity, among all other individual factors. Subsequent meta-analyses (Liu et al., 2016; Ng & Feldman, 2012) found similar results regarding employee creativity. Creative self-efficacy is also a strong moderator, between job self-efficacy and creativity (Tierney & Farmer, 2002) self-expectations for creativity and creativity (Carmeli & Schaubroeck, 2007), as well as group and supervisor support and creativity (Diliello et al., 2011). It is also a key mediator, as it mediates the relationship between learning orientation and creativity (Gong et al., 2009) optimism and creativity (Li & Wu, 2011), or between transformational leadership and creativity (Gong et al., 2009). These results suggest that creative self-efficacy is a compelling and important driver for creativity in the workplace.

Hypothesis 6: Creative self-efficacy is necessary for creativity in the workplace.

Creative process engagement

Creative process engagement can be defined as the extent to which an employee engages in creativity-relevant processes or methods, and includes three main steps : (1) problem identification, (2) information seeking and encoding, and (3) idea generation (Zhang & Bartol, 2010b). Creative work involves often ill-defined problems, which imply that the solver must first identify and construct the problem (Reiter-Palmon & Illies, 2004). Following this first step, one must retrieve and gather new information, which will then be integrated, connected and combined (Bink & Marsh, 2000). Without searching and encoding, no new idea can be formed, or eventual new ideas will not differ much from older ideas. After new information is available, idea generation can eventually take the floor. Creative process engagement is essential to an employee's creativity, as it “determines the flexibility with which cognitive pathways are explored, the attention given to particular aspects of the task, and the extent to which a particular pathway is followed in pursuit of a solution” (Amabile, 2018, p. 95). Multiple studies have shown that creative process engagement is an important predictor and mediator of employee creativity (Harris et al., 2014; Tan et al., 2019; Zhang & Bartol, 2010a, 2010b). If an employee does not engage in creativity-relevant processes, creative performance or problem-solving should not be able to emerge.

Hypothesis 7: Creative process engagement is necessary for creativity in the workplace.

Necessary Condition Analysis

A necessary condition enables the outcome when present, and prevents it when absent (Dul, 2016). A “necessary but not sufficient” relation between a condition X and an outcome Y results in a scatterplot comprising an empty space in the upper left corner, that contains no data. Necessary Condition Analysis (NCA), at its core, consists of drawing a ceiling line that

delimits the border between the empty space and the full-data area. This empty space means that, with a given level of X , Y cannot go higher than the ceiling line. It does not mean that this given level of X is sufficient for Y to occur, but that it is necessary for Y to occur. Hence, X is a “necessary but not sufficient” condition of Y .

There are two main techniques to draw the ceiling line: Ceiling Envelopment – Free Disposal Hull (CE-FDH) and Ceiling Regression – Free Disposal Hull (CR-FDH). The CE-FDH ceiling line does not allow for points above the line, and results in a “piecewise linear function along the upper left observations” (Dul, 2016, p. 27). We can formulate the drawing process as follows: start at $Y = Y_{\min}$ for $X = X_{\min}$, then move vertically towards the largest Y for $X_{\min}$. Then, move horizontally until reaching an observation on or above this line, then move vertically until reaching the maximum Y for this X . Repeat this process until reaching $X = X_{\max}$. The points at each upper left corner are called the “peers”. The CR-FDH ceiling line corresponds to a straight trend line through these peers. This trend line is a simple linear regression, with minimization of the squared vertical distance of the line to the peers. Hence, some points will appear above this trend line, contrary to CE-FDH.

After drawing the ceiling line, we can calculate the size of the empty space, the ceiling zone. The necessity effect size (d) is equal to the ceiling zone divided by the total-data area (the scope), and ranges from 0 to 1. Based on Dul’s recommendations (2019), $0 < d \leq 0.1$ is considered a small effect, $0.1 \leq d \leq 0.3$ a medium effect, $0.3 \leq d \leq 0.5$ a large effect, and $d \geq 0.5$ is considered a very large effect. A significance test is then performed, by comparing the effect size of the observed sample to the effect sizes of samples where X and Y are unrelated, using an approximate permutation test (for detailed explanations, see Dul et al., 2020).

In the creativity literature, Karwowski et al. (2016) used NCA to examine whether intelligence was necessary for creativity, based on the threshold hypothesis (Guilford, 1967; Jauk et al., 2013). Using a vast array of creativity measures, they found that intelligence was

indeed a necessary - but not sufficient – condition creativity. On a predictor point of view, Lamri & Lubart (2019) used NCA to test whether creativity, critical thinking, collaboration, and communication were necessary in order to achieve high workplace performance. Their results suggested that all four variables, including creativity, were necessary conditions for high performance.

Method

Sample and data collection

We collected data from 1384 workers, who were recruited online through French social networks. The average respondent was 40.2 years old ($SD = 11.2$, range = 18 to 74). 88.1% were women, and 31.9% of participants held a managerial position. The median reported company size was 137 workers. The data collection respected the General Data Protection Regulation (EU) 2016/679 (GDPR).

Measures

Creativity in the workplace. Creativity was measured with a 13-item scale developed by Zhou & George (2001), using a 7-point Likert Scale. It was originally designed for supervisors to assess employee creativity. The instructions were modified to obtain a self-report version, as self-reported measures of creativity were shown to yield satisfactory results (e.g. Cai et al., 2019; Ng & Feldman, 2012; Tan et al., 2019). It was translated to French using a back-translation procedure (Brislin, 1986). A sample item is “I am a good source of creative ideas”. The internal consistency of the scale was high ($\alpha = .92$)

Creative personality. We assessed creative personality (CP) with the French version of the Creative Personality Scale (CPS, Gough, 1979). The scale is composed of 18 positive adjectives and 12 negative adjectives, and participants were asked whether each adjective described them or not. Positive adjectives are assigned a value of +1 when selected, and

negative ones a value of -1, so the total score can range from -12 to +18. Sample adjectives are “inventive” and “insightful”. We used the Kuder-Richardson formula 20 (KR-20, Kuder & Richardson, 1937), to calculate the internal consistency of dichotomous items. The internal consistency was acceptable (KR-20 = .66).

Openness to experience. Openness was measured with the Openness subscale of the French version of the HEXACO-60 (Ashton & Lee, 2009). It is a 10-item scale, using a 7-point Likert scale. Sample items are “People have often told me that I have a good imagination” and “I like people who have unconventional views”. The internal consistency was satisfactory ($\alpha = .73$).

Creative process engagement. We measured creative process engagement (CPE) with a 11-item scale developed by Zhang & Bartol (2010b), using a 7-point Likert scale. The scale has three dimensions: problem identification (three items), information seeking (three items), and idea generation (five items). Sample items are “I spend considerable time trying to understand the nature of the problem” (problem identification), “I search for information from multiple sources” (information seeking), and “I generate a significant number of alternatives to the same problem before I choose the final solution” (idea generation). It was translated through a back-translation procedure. To calculate the overall internal consistency, we used McDonald’s omega (McDonald, 1999). This is an alternative to Cronbach’s alpha, when one wants to estimate the internal consistency of a multidimensional scale. It posits the existence of a common factor on which all items load, in addition to the original factors. Confirmatory factor analysis with three first-order factors and one common factor yielded acceptable indices: $\chi^2(27) = 97.97$, $p < .001$, CFI = .993, TLI = .985, RMSEA = .033, SRMR = .017. The internal consistency was high ($\omega = .89$).

Job self-efficacy. We assessed job-self efficacy (JSE) with a 10-item scale developed by Riggs et al. (1994), using a 7-point Likert scale. A sample item is “I have confidence in my

ability to do my job”. It was translated through a back-translation procedure. The internal consistency was satisfactory ($\alpha = .79$).

Creative personal identity and creative self-efficacy. Creative personal identity (CPI) and creative self-efficacy (CSE) were assessed with the Short Scale of Creative Self (SSCS, Karwowski, 2012; Karwowski et al., 2018), using a 7-point Likert scale. The SSCS is a 11-item scale, with five items measuring creative personal identity and six measuring creative self-efficacy. Sample items are “My creativity is important for who I am” and “I am sure I can deal with problems requiring creative thinking”, respectively. It was translated through a back-translation procedure. Both subscales had good internal consistency (CPI - $\alpha = .90$; CSE - $\alpha = .82$).

Intrinsic motivation. We measured intrinsic motivation (IM) with the corresponding subscale of the Work Preference Inventory (WPI, Amabile et al., 1994), using a 7-point Likert scale. It is a 15-item scale, composed of two secondary scales: challenge (five items) and enjoyment (ten items). Sample items are “I enjoy tackling problems that are completely new to me” (challenge) and “What matters most to me is enjoying what I do” (enjoyment). It was translated through a back-translation procedure. We used McDonald’s omega to calculate the internal consistency. Confirmatory factor analysis with two first-order factors and one common factor yielded acceptable indices: $\chi^2(72) = 310.98$, $p < .001$, CFI = .945, TLI = .92, RMSEA = .049, SRMR = .033. The internal consistency was satisfactory ($\omega = .76$).

Results

Because all data were collected from a single source, we checked the presence of common source bias, using Harman’s single-factor test (Harman, 1976; Podsakoff & Organ, 1986). First, we conducted an exploratory factor analysis, with a maximum likelihood extraction, to determine if one factor would account for a majority of the total variance. The

first extracted factor explained only 15.82% of the total variance, suggesting no common source bias. Second, we conducted a confirmatory factor analysis in which all items loaded on a single factor. This model yielded mediocre fit indices : $\chi^2(4850) = 29427.32, p < .001$, CFI = .482, TLI = .471, RMSEA = .061, SRMR = .073. These results led to reduced concerns over common source bias.

The means, standard deviations, and correlations of all the measures are presented in Table 1. Consistent with previous findings, all variables were positively related to creativity, with correlations ranging from .31 to .69, and all correlations with creativity were significant ($p < .001$).

We applied NCA using the NCA package version 3.0.2, in R (Dul & Buijs, 2019). The scatterplots for creative personality, openness, creative personal identity, creative process engagement, and creative self-efficacy (see Figure 2) all indicated a blank space, suggesting a necessary condition was present. However, the scatterplots for intrinsic motivation and job self-efficacy did not indicate such blank spaces. These findings were consistent with effect sizes (see Table 2), for both CE-FDH and CR-FDH. For the calculation of statistical significance of effect sizes, we conducted an approximate permutation test with the recommended 10000 resamples (Dul, 2019). Using CE-FDH ceiling line, we found significant small effect sizes for creative personality ($d = .10, p < .001$), openness ($d = .06, p < .05$), creative personal identity ($d = .06, p < .001$) and creative process engagement ($d = .09, p < .001$). The effect size of creative self-efficacy was medium and significant ($d = .20, p < .001$). Consistent with their scatterplots, we found no significant effect sizes for intrinsic motivation ($p = .50$) and job-self-efficacy ($p = .73$). Hypotheses 1, 2, 3, 6 and 7 were supported by our data. Creative personality, openness, creative personal identity, creative self-efficacy and creative process engagement are necessary conditions for creativity in the workplace.

However, our results do not support hypotheses 4 and 5. Intrinsic motivation and job self-efficacy are not necessary conditions for creativity in the workplace.

Of particular interest is the bottleneck table (see Table 3). This table indicates the threshold level of a given variable necessary to enable a desired level of creativity, expressed here in percentage. 0% represents the lowest level of creativity, 50% is average, and 100% means the highest level possible, based on the scale we used. Values were obtained using CE-FDH ceiling line. If one wants to achieve average-to-good creative performance, shown in Table 3 between 50 and 79%, it will require low levels of the necessary conditions. This is consistent with the small effect sizes we found for these necessary conditions. If one wants to achieve higher levels of creativity ($\geq 80\%$ in Table 3), it will require a moderate-to-high level of creative self-efficacy (41.7-69.4%), a low-to-moderate level of creative process engagement (16.7-47%), a low-to-moderate level of creative personal identity (10-60%), a low-to-moderate levels of openness (8.9%-46.4%), and a low level of creative personality (14.3-28.6%). To illustrate the threshold nature of necessary conditions: if one checks all these conditions but has a creative self-efficacy below 41.7%, creative performance above 79% will not be possible. This means also that raising any other given condition to the level necessary for higher creativity will be ineffective, unless creative self-efficacy reaches the necessary threshold as well.

Discussion

Are there necessary conditions for creativity, and if so, what are they? We found that creative personality, openness, creative personal identity, creative self-efficacy, and creative process engagement were necessary conditions for creativity. All effect sizes were small but significant, excepting creative self-efficacy which demonstrated a medium effect size. Intrinsic motivation and job self-efficacy were not identified as necessary conditions, contrary to our hypotheses.

Our results provide several contributions to the existing literature. Methodologically, this is the first study to use NCA in the field of creativity in the workplace, and as such is the first to bring insights into the conceptualization of necessary conditions for employee creativity. Correlation and regression analyses can spot important determinants that contribute on average to creativity, but NCA can highlight necessary (or critical) determinants that prevent creativity from emerging in the workplace. The two approaches are unquestionably complementary, but fundamentally different. Determinants that show small or no effects in traditional approaches can be identified as necessary, and others that show large effects may prove not to be critical, thanks to NCA (Dul, 2016). This does not mean that an important contributing factor is no longer important when identified as non-necessary. Travelling from Paris to Rome by plane is a sufficient method, and a quick one at that, but is most certainly not necessary: one can achieve the same result by other means of transport.

Componential theories have dominated the literature on creativity (Amabile & Pratt, 2016; Lubart, 1999; Sternberg & Lubart, 1995). The components in these theories can be viewed as the foundations, upon which the creative performance lays. Our results demonstrate that this base-layer is necessary for creativity. Indeed, several conative factors we examined – openness, creative personality, and creative personal identity – were necessary conditions, as well as creative process engagement. However, all their effect sizes indicated small effects (ranging from .06 to .10). Hence, even if our hypotheses were all confirmed *in nature*, they need to be nuanced when considered *in degree*. When one aims for an average-to-good level of creativity (shown from 50 to 79% in Table 3), the necessary condition levels are only low percentages. This suggests that most employees could reasonably be capable of such performance, as the conditions needed to enable this level of creativity are within the grasp of the majority of individuals. Only when aiming for high-to-top creative performance (above

80% in Table 3) do these components become critical, as the required levels of these conditions grow higher.

Motivational components, or drivers, are present in nearly all theories of creativity and innovation (for a review, see Kaufman & Glăveanu, 2019). Individuals need a driving force, and the literature has shown motivation was of utmost importance for creativity (Hennessey, 2019). In our study, we examined the potential necessity of three instances of drivers: intrinsic motivation, job self-efficacy and creative self-efficacy. Our results did not confirm all of the hypotheses. Intrinsic motivation and job self-efficacy, although important contributors to creativity, were not necessary conditions for creativity. This was surprising, but not unexplainable. As stated previously, a condition can be “sufficient but not necessary”. In other words, such conditions are “good to have” but are not “must-haves”. This means that, whereas intrinsic motivation is arguably an important contributing factor to creativity, it is neither critical nor necessary. As such, other factors can compensate its absence, such as extrinsic motivation, which has been shown to be beneficial to creativity (Amabile & Pratt, 2016; Hammond et al., 2011). The same goes for job self-efficacy: it is an important factor, but it is not necessary for creativity to occur in the workplace. On the contrary, creative self-efficacy was identified as a necessary condition for creativity. Notably, it had the largest effect size among all factors examined ($d = .20, p < .001$). This indicates that creative self-efficacy is a critical driver for creativity. In the absence of high-enough levels of creative self-efficacy, high-to-top creative performance will not be possible, regardless of all other factors. As stated previously, this does not mean that these components cause creativity to occur in the workplace. Rather, it indicates that achieving a certain creative performance is enabled by the presence of the right levels of its necessary conditions and impeded by their absence.

Practical implications and future directions

The identification of necessary conditions for creativity has great practical significance. Organizational decision makers should be aware of the difference between necessity and sufficiency. Taking stock of the critical factors for creativity can help guide the allocation of effort. Here, this means that individuals with low creative potential can nonetheless achieve decent or even high creative performance. More effort should be directed towards creative self-efficacy, as it proved to be critical to creativity. Research has shown the level of creative self-efficacy is not fixed (Grosser et al., 2017; Mathisen & Bronnick, 2009). Organizations can shape positively the sense of efficacy of their employees, and leaders play an important role in that (Chong & Ma, 2010; Mathisen, 2011). Creative activities are challenging and individuals pursuing creative goals are bound to face failures and doubts about their creative capacities (Ford, 1996). Validation can play a major role in preventing that, through expectation-inspired leadership (Eden, 1992) and the Pygmalion effect. When a leader conveys expectations regarding an employee's creativity, this will contribute to the employee's creative self-efficacy (Tierney & Farmer, 2004, 2011). In other words, if “my supervisor expects me to be creative”, this must be because “I am good at creative tasks”. Training leaders for efficacy building, notably to convey expectations for creativity and related feedbacks, will prove fruitful in this sense.

The present work has limitations but opens the path to further research. Most evidently, the use of self-report measures for creativity can be debated (Park et al., 2016). However, we believe their use was justified in this study, as they can yield satisfactory and valid results (Ng & Feldman, 2012). Future studies could focus on more objective assessment of creative performance, such as patents or awards (Zhou & Shalley, 2003). Second, we opted for a rather simple conceptualization of task motivation. It is indeed a complex concept, that can be explored in much more depth (Hennessey, 2019; Hennessey & Amabile, 2010).

Future studies are encouraged to use more detailed assessments of motivations, drawing on self-determination theory (Gagné et al., 2015). Finally, we observed significant effect sizes for both openness to experience and creative personality. It should be noted that NCA processes each condition independently, but conceptual overlaps between these constructs (Barron & Harrington, 1981) might explain why both proved necessary. Despite these limitations, this study provides an important contribution to the literature and extends our understanding on the notion of necessity in creativity research, which has been traditionally neglected over the past century of research on creativity, in general, and creativity in the workplace, in particular.

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Figure 1*Conceptual model*

Figure 2

Visualization of the NCA across all factors. Green lines denote the linear function, solid orange lines denote the CR-FDH ceiling line, and broken red lines denote the CE-FDH ceiling line

Note. CP : creative personality, CPE : creative process engagement, CPI : creative personal identity, IM : intrinsic motivation, JSE : job self-efficacy, CSE : creative self-efficacy.

Table 1*Descriptive statistics and correlation matrix*

	Mean	SD	Skewness	Kurtosis	Creativity	CPE	IM	JSE	CSE	CPI	Openness	CP
Creativity	5.14	1.00	-0.51	0.50	—							
CPE	4.89	0.86	-0.49	1.43	0.49 ***	—						
IM	5.50	0.65	-0.49	0.41	0.53 ***	0.42 ***	—					
JSE	5.42	0.92	-0.73	0.85	0.32 ***	0.08 **	0.26 ***	—				
CSE	5.08	1.02	-0.41	0.13	0.69 ***	0.43 ***	0.47 ***	0.29 ***	—			
CPI	4.86	1.42	-0.45	-0.36	0.56 ***	0.36 ***	0.34 ***	0.10 ***	0.77 ***	—		
Openness	4.77	1.06	-0.27	-0.45	0.31 ***	0.29 ***	0.26 ***	0.10 ***	0.41 ***	0.48 ***	—	
CP	3.76	3.47	-0.21	-0.21	0.43 ***	0.25 ***	0.28 ***	0.32 ***	0.52 ***	0.45 ***	0.37 ***	—

Note 1. * $p < .05$, ** $p < .01$, *** $p < .001$

Note 2. CP : creative personality, CPE : creative process engagement, CPI : creative personal identity, IM : intrinsic motivation, JSE : job self-efficacy, CSE : creative self-efficacy.

Table 2*Effect sizes*

	CE-FDH	p	CR-FDH	p
Openness	.06	.034	.07	.004
CP	.10	.000	.07	.000
CPE	.09	.000	.09	.000
CPI	.06	.000	.07	.000
IM	.06	.501	.03	.748
JSE	.04	.730	.02	.854
CSE	.20	.000	.19	.000

Note. CP : creative personality, CPE : creative process engagement, CPI : creative personal identity, IM : intrinsic motivation, JSE : job self-efficacy, CSE : creative self-efficacy.

Table 3*Bottleneck table – CE-FDH*

Creativity	Openness	CP	CPE	CPI	IM	JSE	CSE
0	NN	NN	NN	NN	NN	NN	NN
10	NN	NN	NN	NN	NN	NN	NN
20	NN	4.8	NN	NN	NN	NN	NN
30	3.6	4.8	NN	NN	NN	NN	NN
40	3.6	4.8	NN	NN	NN	NN	NN
50	3.6	9.5	4.5	NN	NN	NN	22.2
60	3.6	9.5	16.7	NN	NN	NN	25.0
70	3.6	9.5	16.7	10.0	NN	NN	33.3
80	8.9	14.3	16.7	10.0	NN	13.3	41.7
90	19.6	28.6	16.7	10.0	40.9	13.3	50.0
100	46.4	28.6	47.0	60.0	40.9	13.3	69.4

Note. CP : creative personality, CPE : creative process engagement, CPI : creative personal

identity, IM : intrinsic motivation, JSE : job self-efficacy, CSE : creative self-efficacy, NN :

non-necessary.